Society for Mathematical Biology

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IN THIS ISSUE

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Letter from the President

Dear SMB members,

Thanks to Maya Shmailov, we are being challenged to rethink the life and work of Nicolas Rashevsky, who I mainly knew of as playing some role in founding this Society and its journal, and as representative of the "old school" of mathematical biology that had to be displaced by the newer and better version we all unthinkingly practice today. This displacement, in turn, somehow paralleled the progress of science itself from a top-down to a bottom-up way to explain the world. Because I have only begun to learn about Rashevsky's actual thought, which is perhaps only now sufficiently far in the past to see with unbiased eyes, I won't attempt to defend or debunk this view, but will instead reflect upon its relevance for science and scientific organizations.

My thinking on the progress of science has been shaped by my reading of Galileo's "Dialogues Concerning Two World Systems", a wonderful set of arguments by one of my intellectual heroes. Amidst sections that seem utterly contemporary are several baffling geometric arguments, that seem based on assumptions that objects have a natural tendency to follow circular, linear or other geometrically simple paths. This top-down mode of explanation was utterly replaced by Newton's bottom-up explanation of these paths as consequences of local forces, an explanation that exiles global causes and action at a distance and serves as a model of reductionism. In this light, Rashevsky's "Principle of Optimal Design" and "Generalized Postulate of Relation Forces" sound distinctly top-down, and in conflict with explanations based either on the short-sighted workings of evolution or the local interactions of molecules.

Although at heart wishing to be a holist, I have increasingly become a "pointy-headed reductionist," although always drawn forward by the dream that mathematical methods will provide a holistic understanding of emergent properties. It is some disparaging comments about reductionism made recently, and in my general direction, by an unnamed ex-President of SMB (hereafter EPSMB) that have me thinking about broad challenge once again. The EPSMB is certainly correct that excessive reductionism surrenders the ultimate goal of explanation, and conflates a detailed parts list with discovery. So have the errors of top-down holism only been replaced by the limitations of bottom-up reductionism?

Although I think most of us would agree that a combined approach is best, this condemnation of bottom-up science is in strange contrast with the diametrically opposite view many of us have come to with regard to teaching and management. Top-down teaching, where the expert lecturer imposes an worldview is rightly disparaged, and should be replaced by bottom-up learning generated by student inquiry, with expert instructors serving to extract principles and understanding. Similarly, the best ideas in this organization come from the members, leaving it to current and future leadership (and even EPSMBs) to integrate them into a whole that is greater than the sum of its parts. The challenges of advancing understanding, helping young scientists, linking teaching with research, and providing a foundation for the biological sciences remain largely the same as when first faced by Rashevsky himself. Or, to conclude with a toast to all our members: "May the New Year bring our best ideas to light! Bottoms up!"

Sincerely,

Fred Adler

The 2015 SMB Annual Meeting - Poster

Call for Minisymposium Proposals

http://math.gsu.edu/~smb/

by Yi Jiang

You are cordially invited to submit a minisymposium proposal for the 2015 Annual Meetings of SMB, to be held in Atlanta, June 30 - July 3, 2015. The deadline for minisymposium proposal is **January 31, 2015**. Please use either the Word or LaTeX template to prepare your proposal, and submit the proposal, by January 31, to via email to smb15@gsu.edu. Please see: `http://math.gsu.edu/~smb/call_for_papers.html` to download Word or LaTeX template.

Topics for Mini-Symposia and Contributed Sessions include but not limit to:

- Biomechanics of Soft Biological Tissues
- Biological Networks and Systems
- Bioinformatics
- Bio-Imaging and Pattern Quantification
- Evolution and Ecology
- Infection and Immune Response
- Infectious Diseases / Public Health Management
- Mathematical and Quantitative Oncology
- Mathematical Modeling in Medicine
- Mathematical and Computational Modeling of Cardiodynamics
- Molecular Systems Biology
- Multiscale Modeling Techniques in Biology
- Computational and Mathematical Neuroscience
- Population Dynamics
- Stochasticity in Biology
- Special session on Education in Theoretical, Mathematical, and Systems Biology
- Special Forum on Career Development: how to communicate with biologists, how to publish in high impact journals, how to land a tenure track position, how to obtain funding, how to manage a research lab

We look forward to hearing from you.

Yi Jiang (on behalf of the organizing committee)

SMB Prizes Announcement - Congratulations!

Okubo Prize

Joshua Plotkin

The Society for Mathematical Biology and the Japanese Society for Mathematical Biology are pleased to announce that the 2015 Akira Okubo Prize will be awarded to **Joshua Plotkin**, Professor of Biology and Computer Information Science at University of Pennsylvania. In 2015, the Okubo Prize is awarded to a scientist under 40, for outstanding and innovative theoretical work, for establishing superb conceptual ideas, for solving tough theoretical problems, and/or for uniting theory and data to advance biological science. Professor Plotkin's outstanding research achievements in his career to date amply satisfy these exacting criteria and do credit to the memory of Professor Akira Okubo.

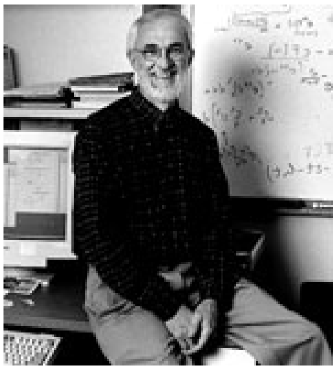
Professor Plotkin's undergraduate degree was in mathematics from Harvard University. He then moved to Princeton, as a PhD student under the supervision of Simon Levin and Martin Nowak. He was the first graduate from the Burroughs Wellcome Fund Interfaces Program at Princeton, and was later awarded a BWF Career Award at the Science Interface. His doctoral and post-doctoral research used mathematics to make significant impacts on a wide range of biological debates. This includes work on tropical trees and species-area curves, the evolution of language and language acquisition, and the role of apoptosis and DNA repair in tumorigenesis.

More recently Professor Plotkin has focussed on theoretical modeling in evolutionary biology. He has worked extensively on the influenza virus, where he has analyzed unique data sets in ways that have exposed novel structure in the diversity of strains. His theoretical work in this area has potentially significant implications for public health. More generally, a particular focus of his recent research has been on adaptation in populations. For example, his work has provided a theoretical basis for the role of neutral mutations, and for inferring properties of an organism's fitness landscape from temporal data.

Professor Plotkin's research achievements belie his young age. His work is exciting and innovative, addressing fundamental issues in population genetics and evolution. It is with great enthusiasm that the committee awards him the 2015 Akira Okubo Prize.

Yoh Iwasa
Michio Kondoh
Michael Neubert
Hans Othmer
Jonathan Sherratt (chair)
Yasuhiro Takeuchi

Arthur T. Winfree Prize



John Rinzel

John Rinzel is the recipient of the 2015 Arthur T. Winfree Prize for his elegant work on the analysis of dynamical behavior in models of neural activity and the contributions that work has made in the neurobiological community to the understanding of a host of phenomena (including simple excitability as well as bursting) in single neurons, small populations of neurons, and other excitable cells.

Congratulations again,

Jim Keener
Anita Layton
Mike Mackey

MBI Capstone Conference for Biomathematics Undergraduates

Columbus, Ohio, August 11-15, 2014

by DOMINICK DIMERCURIO II

Mathematical Biosciences Institute (MBI) at Ohio State University hosted the Undergraduate Research Capstone Conference from August 11-15, 2014. A total of seventy seven students from 48 universities and institutions, showcased their research in posters and talks. Research topics varied from the effect of locomotion on body temperature control in rats, to the biophysics of nuclear migration in reproducing C. elegans cells, to the SXR model of hospital-associated infections. In addition, three expert keynote speakers presented their research in anesthesiology-statistics, integrative biology, and statistical agronomy.

Emery Brown, MD, PhD, of MIT discussed the loss of the recovery of consciousness in patients treated with the anesthetic propofol. "*The brain isn't turned off,*" explained Dr. Brown. Many neural dynamics still operate while a person is under anesthesia, as shown in the electroencephalograph data of anesthetized patients.

Dr. Robert J. Full, professor from the Department of Integrative Biology at UC Berkeley, explained how he and his colleagues studied computational, robotic, and animal models of movement, giving rise to the new field Terradynamics. "*The collective discoveries [of multiple disciplines] are beyond what any single discipline can do,*" Dr. Full proclaimed, as he discussed the interactions between researchers in mathematics, engineering, and biology.

Dr. Rebecca Doerge from the University of Purdue lectured on statistics in the context of agricultural genetics. In particular, Doerge explained that identifying the difference between the Poisson distribution versus overdispersion in a dataset allowed her team of statisticians to model genomic data appropriately. The professional keynote speakers energized and inspired the undergraduates as the students presented their own research projects during the week of the capstone conference.

The undergraduate students also received valuable advice from graduate school admissions panels. Two representatives from graduate school admissions in Arizona State University and the Ohio State University explained to the undergraduates the process of applying to graduate school and important information for applications. Students were also able to talk, both in person and remotely via Skype, to professors from universities across the nation affiliated with MBI, coming from programs with an emphasis in systems biology or other related fields. In addition to networking with graduate school admissions board representatives, undergraduates had numerous opportunities to network with one another as well. The undergraduate students entertained a visit to the Columbus Zoo, and afterward MBI treated the students to a family-style dinner at a local Chinese restaurant.

The conference emphasized that, in today's scientific pursuits, a single discipline is often inadequate to answer the questions that cover a broad array of fields. Applied mathematics provides scientists with mathematical models and engineers with theoretical designs; in return, science and engineering provides mathematics with novel systems to explore. In an interdisciplinary interaction, both disciplines can expand to new territory. Through their research this summer and this conference in August, these undergraduate students learned to appreciate biomathematical research and its greater implications in science, engineering, and medicine as interdisciplinary work grows among modern scientists. More information about this event and the students' talks, can be found here: `http://mbi.osu.edu/event?id=874`. To learn more about similar events, check out the events calendar on the MBI website: `http://mbi.osu.edu/`

The BIOMAT 2014 International Symposium

Bedlewo, Poland, November 3 - 8, 2014

by R.P. Mondaini

Report by an SMB Grant Recipient

The BIOMAT 2014 International Symposium, the 14th International Symposium of the BIOMAT Series, was held at the Bedlewo Conference Centre of the Stefan Banach International Mathematical Centre, Institute of Mathematics, Polish Academy of Sciences on November 3-8, 2014. The organization of the Scientific Program followed the traditional guidelines of the BIOMAT Consortium, an International non-profit scientific association which is responsible by the organization of this annual series of international conferences. BIOMAT was founded in April 2001.

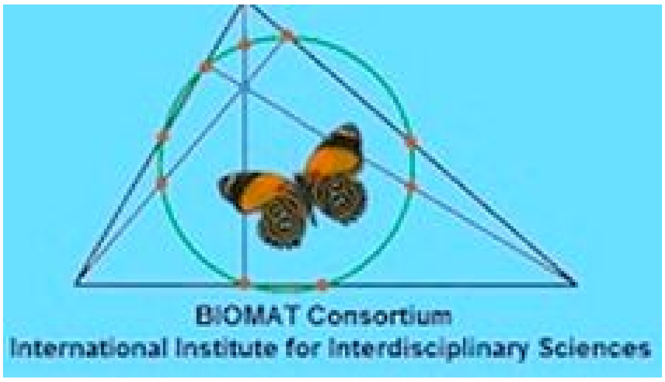
BIOMAT 2014, had fourteen Keynote Speakers on Plenary talks including two Tutorial talks, which are usually given by internationally renowned professionals in order to motivate the enhancement of the scientific work of research students and young postdocs on interdisciplinary topics covered by the BIOMAT Consortium. There were also forty six contributed talks, by researchers and some selected students, providing time to present their research results to an expert audience. Participants came from eighteen countries, on the Americas, Europe, Africa and the Middle East.

The scientific program has followed the traditional requirement of continuous sessions as an international workshop of scientific excellence, which has been proven to be the best way of favoring the exchange of scientific feedback among professionals of different academic educations but with interest on very similar research problems. The expertise of selected chairs of the twenty scientific sessions assured the fulfillment of this essential requirement. The BIOMAT Consortium is indebted to all of them by the excellent organizational work.

BIOMAT is indebted to the staff of the Bedlewo Conference Centre. Their expertise on the organization of scientific conferences added to the expertise of the BIOMAT Consortium in a marvelous symbiosis, following the BIOMAT Consortium fine traditions and fundamental mission of enhancing scientific work on interdisciplinary topics of mathematical and biological sciences since inception.

BIOMAT is grateful to the Society for Mathematical Biology for their financial support. SMB funding was awarded to eight selected students to cover the full cost of room and board.

Further information can be found on the symposium's website: `http://biomat.org/biomat2014/indexbiomat2014.html`



Tumor-Immune Dynamics

San Jose, California, January 5 - 9, 2015

by Amina Eladdadi, Peter Kim & Chae-Ok Yun

The workshop on Tumor-Immune Dynamics Modeling was held at the American Institute of Mathematics (AIM) at the new location in San Jose, California on January 5-9, 2015. It was co-organized by Amina Eladdadi from the College of Saint Rose, Peter Kim from the University of Sydney, and Chae-Ok Yun from Hanyang University in Korea. This workshop was jointly sponsored by AIM and NSF.

The workshop brought together twenty-one leading experts and junior scientists in applied and computational mathematics, biology, as well as clinical medicine. The participants came from the US, Canada, Australia, Korea, France, Italy, Mexico, Morocco and South Africa. They all gathered with a strong interest in understanding the complex interactions between the immune system and tumors to help devise predictive mathematical models.

The organizers welcomed the participants and thanked them for taking a full week from their busy schedules to attend the workshop. They gave a brief summary of the events that led up to this workshop and outlined the plan for the whole week. The organizers reiterated the main goals of the workshop, and then stressed that its success depended on the full participation from the audience by leading topic-focused discussions to solve specific problems in tumor-immune dynamics. The organizers put together a great program, which included an extensive and interactive lecture each morning followed by two parallel - ask the experts panel- discussions on the first day, breakout working sessions, and general discussion sessions for reporting.

Speakers did a superb job in providing the participants with the background material leading up to specific problems. Chae-Ok Yun, a biologist from Hanyang U. in Korea, gave the first talk of the workshop titled "*Immuno Gene Therapy Using Oncolytic Adenovirus.*" Heinz Schättler from Washington U. in St. Louis lectured on "*Cancer Chemotherapy and Tumor-Immune Dynamics.*" Dominik Wodarz, from the U. of California, Irvine talked about "*Mathematical Models of Oncolytic Virus Therapy.*" Lisette de Pillis, from Harvey Mudd College, addressed "*Tumor-Immune Modeling.*" Dr. Peter Lee, MD, from City of Hope gave a talk on the "*Important Issues in Cancer Immunotherapy.*"

The parallel ask-the-experts sessions generated a lot interesting questions from the participants. These questions fell into three categories: (Co)-evolutionary dynamics, modeling therapies and combined therapies, optimization, and spatial dynamics. The participants then broke into three teams based on their interests to address the following three main problems: (1) How do components of the immune system synergize to limit cancer progression? (2) Can we characterize the dynamics of combination therapies, such as virotherapy combined with chemotherapy, radiotherapy, and/or dendritic cell vaccines? (3) Can we model viral spread/diffusion throughout a tumor?

Through a series of brief informal reports by the participants and elaborate discussions, these interactive working sessions focused on developing mathematical models to answer the three main questions proposed by participants.

There was plenty of time devoted to the parallel breakout sessions every day. All participants actively engaged in cross-disciplinary discussions on various aspects of tumor-immune dynamics. The workshop was very stimulating and engaging with a lot of opportunities for interactions. It provided a great and informal forum for mathematicians, experimentalist and clinicians to discuss their work. Furthermore, the meeting allowed participants to foster new cross-disciplinary collaborations to understand key interactions between the immune system and tumors.

Finally, on behalf of all the participants, the organizers would like to thank the staff of AIM for their kindness and hospitality and acknowledge the generous financial support from AIM and NSF (see: `http://aimath.org/workshops/upcoming/tumorimmune2/`)

Who is Nicolas Rashevsky?

by Maya M. Shmailov

Nicolas Rashevsky was a theoretical physicist who pioneered mathematical biology, and is also considered the father of mathematical biophysics and theoretical biology

"Most modern-day biologists have never heard of Rashevsky. Why?" This question, posed to me by evolutionary biologist, Richard Lewontin set me on a journey of discovering who Nicolas Rashevsky was. In a first detailed biography of Nicolas Rashevsky, covering main aspects of his long career, my work captures Rashevsky's ways of thinking about the place mathematical biology should have in biology and his struggle for the acceptance of his views. Through his character and his struggles I set out to uncover all that was involved in establishing a new way of thinking in biology.

In the process of reconstructing Rashevsky's career and personality, I recognized that there were in fact many contexts in which he could be placed, and even multiple "identities" that could have been attributed to him. Without claiming that Rashevsky was representative of his peers – in fact, his idiosyncrasies in thought and action were what had interested me in the first place – I wrote the story of his career as a story of an "outsider". By observing the outsider in biology and his discipline crossing act, I draw attention to the methodological and epistemic differences between the outsiders and the insiders, the motivation for the boundary crossing and the general vision the outsider has for biology – the discipline he invades. Rashevsky's intellectual trajectory mimics that of a bouncing ball. It had its peaks and troughs, successes and failures, both in his quest towards scientific recognition and in his pursuit towards institutional recognition. Rashevsky – inspired by a vision, or what could be better characterized as a dream, of establishing mathematical biology similar in structure and aim to mathematical physics – never gave up, fighting indefatigably up to his very last day to transform his aspiration into reality. Never losing sight of the goal, he fought, manipulated and eventually risked his life's enterprise under the toughest of circumstances to establish a new discipline within biology. As such, my inquiry aimed at more than chronicling Rashevsky's scientific work. Lawrence Stark articulated it well in the invitation he posed to Rashevsky to attend the Gordon Research Conference on Biomathematics in 1965 as its primary speaker: Rashevsky's biography is in fact the biography of the development of mathematical biology as a discipline in biology.

The two aims are in fact inevitably interwoven. The definition and conception of mathematical biology as a discipline within biology resulted largely from Rashevsky's identity as an "outsider" and his efforts to secure resources to institutionalize his enterprise and legitimize its work. Facing rejection from journals dominated by "insiders" and desiring a venue for publication, Rashevsky established the Bulletin of Mathematical Biophysics. Faced with the rejection of his methodology, perspectives, and general approach to studying the problems of life, he was unable to secure a comfortable position in the department of physiology and found himself out of place in the department of psychology. In the quest to institutionalize his enterprise, he fought for intellectual, academic, and financial independence which led to establishment of the Section of Mathematical Biophysics, a precursor to the more solid Committee on Mathematical Biology at the University of Chicago. Rashevsky, seeking to legitimize his new enterprise needed the support, recognition, and resources of different audiences. These resources – especially financial support and academic recognition – proved to be crucial for the institutionalization of a new discipline. He tried to obtain these resources by defining his work in ways acceptable to his audience. Thus, for example, recognizing the need to prove the applicability of mathematical biology to biology, he published The Relation of Mathematical Biophysics to Experimental Biology in 1938, the Advances and Applications of Mathematical Biology in 1940 and Some Medical Aspects of Mathematical Biology in 1964, thereby demonstrating to the audience in the academic arena why the new enterprise was necessary, legitimate, and significant.

To propagate his views to audiences in the academic arena, Rashevsky organized various scientific meetings and international conferences where fellow scientists interested in his line of work could participate. He took part in numerous conferences and scientific meetings on the border between mathematics and biology, such as the Cold Spring Harbor Symposia and the Gordon Research Conference. He was invited by universities and institutes in the US, Europe, and Russia as a guest lecturer, preaching like a missionary to anyone who would lend an ear.

Throughout his career and at times incidentally, Rashevsky engaged in boundary-work by concurrently erasing and erecting boundaries to differentiate himself and his enterprise from the existing entities competing for similar resources. By constantly defining the boundaries of mathematical biology and differentiating these from other attempts to introduce mathematical rationale to biology, such as those of Lotka, Thompson, Woodger, Haldane and others, Rashevsky fought not only for academic recognition of his research methodology but also paved the way towards institutional demarcation. With a discipline to be created, the provision of tools, methodologies and intellectual orientations lay uppermost in Rashevsky's mind and forefront in his actions. Creating the necessary intellectual and organizational infrastructure for a discipline was a task that demanded a lifetime of faith and devotion. Yet this was a small price to pay for an expansive dream of systematic mathematical biology. Ironically, it was his yearning and the assertion of the theorists' independence that made Rashevsky's contributions to his own discipline incomplete and controversial. By demarcating mathematical biology from biology, his mathematical biology became completely external to the general practice of biology.

While the eventual demise of the Committee in the late 1960s is often perceived as a failure, the recognition of the new discipline by governmental agencies in the late 1950s and 1960s and the founding of the Bulletin of Mathematical Biophysics, illustrates his success in the arena beyond the academic setting of just one campus, namely, the University of Chicago. Academic politics and social factors played a major role in institutionalizing a new discipline and in its demise. Rashevsky entered the Division of Biological Sciences at the University of Chicago when it was undergoing reorganization—and was then forced to resign under similar conditions. Although Rashevsky's employment and promotion path at the University of Chicago progressed from fellow (1934-1935) to Professor (1947-1964), he encountered several setbacks along the way that threatened his enterprise.

Yet Rashevsky's success is ambiguous at best. Back in 1939, one commentator stated that "mathematical biology will never develop unless somebody starts the process... fortunately it [was] started with the work of ... Rashevsky". Despite his role as a pathfinder, Rashevsky's influence on the discipline he labored so faithfully to create has been obscured by his assertion of the theorist's independence as well as the independence of his discipline. Mathematical biology is now a firmly institutionalized field of learning in the United States and elsewhere. At first glance, it bears little trace of Rashevsky's influence, but when examined closely, mathematical biologists today use Rashevsky methodology of abstraction, approximation and isolation to study various biological phenomena. Rashevsky created and assembled the necessary building materials, and he was the first deliberate architect of mathematical biology as an independent and organized discipline. My study of the ways in which he succeeded and those in which he failed illuminates the subtle process of discipline–building and the complex career of a remarkable man.

References:

- Interview and correspondace with Richard Lewontin, February 18, 2011
- Lawrence Stark to Rashevsky, September 22, 1964, Box 10, Folder "Gordon Research Conference", Nicolas Rashevsky's Papers-SCRC, University of Chicago
- Pearl, "Review: Nicolas Rashevsky, Mathematical Biophysics. Physicomathematical Foundations of Biology"

My Personal Journey In Mathematical Biology & Medicine

Jean Clairambault

My long journey in mathematics as applied to biology and medicine began by a training in pure maths, geometry, that did not push me towards applications in any manner. At that time (late seventies), research in geometry was dominated by abstract concepts (e.g., sheaf cohomology), which had little to do with objects that one can touch. Conversely, having been trained in maths, I was demanding on understanding in depth how phenomena occur, not by principles, but by theorems, which will always remain the only way of *proving* results. I was not satisfied either with the idea to be a teacher all my life, although I had passed with success an application (the French agrégation) to obtain the right to teach at least in good conditions if I had to.

I was then available for something new. I have read somewhere that to fall in love, one has to be available for new things, and there should be many examples of this in literature. Well, it can be the same with science. I began with science, being more trained in this domain than in the other (love came a little later, but this is another story). Being thus available, and interested in working on not just transmitting, but as far as possible creating, knowledge in a field where some potential place for maths would exist, I considered different possibilities, among which the most obvious were offered by economics and by biology. I had not had any training in economics and I was very mediocre at biology, making very little sense of what I was taught in the lycée. But I had at the university the example of a geometer who, being one year ahead of me in mathematical studies, was at the same time studying medicine, and dealing with interesting geometrical problems coming from radiology. During my training for the *agrégation*, I had learnt to learn quickly and efficiently, I was not bad either at learning lists and I thought that I might be more useful as a doctor than as a teacher. I should also mention in the personal mental process that led me to medicine the movie by Akira Kurosawa "Akihige" (Red Beard), in which the character played by Toshiro Mifune is both able to break bones if necessary, as the master of martial arts he is, defeating a gang of ruffians who claim to prevent him from taking to his hospital a tuberculous prostitute from the brothel she works in, and later repair them, as the talented surgeon he also is. [When I tell this to my children, they seem to think that it is just one more odd thing of me.] Furthermore, during the summer preceding my first classes in medicine, I spent two months visiting Peru by myself, and the poverty I discovered there convinced me of the interest of being a physician rather than a teacher if one wants to be active and useful.

If I had not studied mathematics first, I might have become one of these "French doctors" for a time. Indeed, one can find real addiction in practicing first aid care or surgery, or even plain medicine when a fast and right diagnosis saves a life. What I discovered early in medicine were first very interesting classes in biology, anatomy and physiology - which then made sense to me, because they were meant to give the basic knowledge necessary to practice medicine - and also a close contact with real life. When you study maths, problems are generally designed in such a way that the student is guided by a succession of questions to the main result to be shown, and it would be unfair to put traps on the way towards the solution. Of course you have to keep in mind that apparently likely things are not true (e.g., that $\exp(A) * \exp(B)$ is not always equal to $\exp(A + B)$ for endomorphisms, etc.), but one learns to be cautious, and you can always count on proofs relying on theorems to sever between true and false. In medicine, nothing of the kind exists. Diagnosis is often difficult, and snares put on your way, just by hazards of life, are frequent. Doubt (popularized by medical TV serials) is also frequent, and no theorems exist to pull you out of it. What you can always reckon on is anatomy and physiology, but whereas anatomy is usually a faithful help, physiology is more ambiguous since its various negative feedbacks may be used to hypothesize one thing and its contrary. So that, confronted with clinical puzzles, rather that indulging in impassioned discussions as in TV serial staff meetings, physicians often apply therapeutic rules learnt in books, updated according to current treatments referenced by the Faculty.

Such generalized absence of theory with sound foundations left me unsatisfied as I had been, years earlier, by sheaf cohomology. I was again available (not in all domains, for I was then married with a newborn child) for discovering new things in maths and in medicine to find my own way. But how can you be useful to medicine when you have studied pure maths? I had in the course of my medical studies taken some time to learn classical statistics (teaching them at the same time, for there is no better way to learn than in teaching), which has always proved useful to me, be it only to understand how statistical tests are used in processing biological data. Being firstly recruited as a volunteer in the research institute that still hires me (on a permanent position now), and later detached in it from the national education service, I learnt at that time basics of signal processing and multidimensional statistical methods to deal with physiological recordings.

This was far from the mathematical modeling and analysis for medicine I am busy with now, but it was necessary to know what biological data are and what sort of physiological hypotheses one can propose from statistical processing of data, according to a well-designed method, to answer a pathophysiological question. The first study I led then was the core of my MD thesis, and it was later extended to more such studies. It was also very useful to me to establish contacts with medical teams, showing that I could provide them with new methods of investigation. Being hired for a prolonged detachment in my institute, I could then begin to get involved in more theoretical studies. It began with cardiac electrophysiology. After some time (ten years), I met an oncologist interested in mathematical modeling, not to understand better cancer treatments by the use of theorems, but to see what new insights mathematical models could bring to his therapeutic practice.

Limited as these expectations may seem, they are not so frequent and show some open-mindedness that allowed me to establish a long-lasting collaboration (twelve years). From it, my regular participation in lab meetings resulted in biological and therapeutic control questions that led me to design models of tumor growth control by drugs, and later to enter in contact with specialists of optimal control, with whom I still work on theoretical optimization of treatments by anticancer drugs. Presently, understanding resistance in cancer to overcome it by optimized time schedules of combinations of drugs is one of my major goals. This also leads me now to try and take advantage, at the genomic era (which includes epigenetics), of data on intracellular signaling pathways, to connect them with cell fate at the level of cell populations, the right level to observe cancer progression and its control by drugs.

Let the reader take this personal journey as a complement to the "Perspective" short paper I published last year in the May issue of this newsletter, and to a paper I published three years ago in Acta Biotheoretica on "Commitment of mathematicians in medicine". I hope that it shows an example of a way of career that may be followed - or on the contrary, that must be absolutely avoided! Example or quixotic counterexample, I will go on searching for theorems to found clinical practice (see on this a perspective I wrote in 2013 for J. Math. Biol.), and if I may have contributed to finding some in the future, I shall be happy with my journey.

About The Author:

Jean Clairambault, PhD, MD, trained - in that order - in mathematics and in medicine, is presently a senior scientist ("directeur de recherche") at INRIA and Laboratoire Jacques-Louis Lions, Pierre et Marie Curie University in Paris. His current interests in research are the emergence of drug resistance in cancer and the evolution from premalignant cell populations to tumors, together with therapeutic optimization methods using combined drug delivery strategies to overcome such evolutions at the cell population level. Website: `http://www.rocq.inria.fr/bang/JC/Jean_Clairambault_en.html`.

Research Interview

Mathematical Biology in the Liberal Arts

Meredith Greer talks with Mark Whidden about her research and the challenges of academic life

Your scientific research focuses on epidemiology and ecology. What attracted you to these fields?
I started undergrad as a biology major, with thoughts of medical school, then switched to math major. Not till graduate school did I first learn mathematical biology existed, and I immediately thought, "THAT'S what I want to do!" It connected two big interests. Epidemiology came first, with a project on prion replication that started from conversations with my Ph.D. advisor, Glenn Webb. I find it fascinating that we can use such similar models to track both disease spread through a human population and virus-or-prion spread within a single human or animal. After earning tenure, I sought new research directions and geographically-close collaborators. Ecology emerged for many reasons: my interests, the wealth of projects in and near Maine, a Bates focus on the environment, and the fact that I could approach ecological modeling using differential equations methods that were familiar from epidemiological work.

You also perform pedagogical research. What innovative strategies have you found effective?
One thing I emphasize is showing students how math is used in the rest of the world. My students attend on-campus talks and read news articles to see this. In upper-level courses, students apply math to current events, such as the recent Ebola outbreak. Some semesters, other Bates classes—in biology and even rhetoric— have met jointly with my math classes to discuss a current topic, each class bringing different knowledge and expertise to the conversation. These have been some of the most fruitful student conversations across all my years of teaching because math students have a personal stake in their work when they are explaining how math can help manage current, real-world problems.

How would you describe the academic climate at Bates College?
Many of my colleagues value interdisciplinary collaboration. Some place a higher value on classical in-discipline research, or they value the idea of interdisciplinary research but haven't found ways to evaluate it that aren't rooted in disciplinary work. Meanwhile, our guidelines for tenure and promotion don't specify what kinds of scholarship "count", and so decisions depend on who serves on that committee in a given year. As a result, we tell our pretenure people to be careful about what they work on in their research. I suspect that's good advice on many campuses.

Are undergraduate students at Bates College involved in aspects of your research?
Yes! Many students write a senior thesis, and some seek opportunities for summer research. Usually, some aspect of my current projects can be "peeled off" for an undergrad to pursue for a while. At times, I've been fortunate to have undergrads doing math modeling with me and also collecting field samples for my collaborator in environmental studies. We would have group meetings with several students working with us to compare mathematical progress, field work, and lab results. These collaborations have pushed forward our research in exciting ways.

What are some of the advantages of being in a liberal arts institution?
Just as mathematical biology spans a whole spectrum between math and biology, liberal arts institutions fall into some sort of middle ground between research-focused universities and institutions with

the heaviest teaching loads. Being in the middle of the spectrum gives us wiggle room in exactly how to intertwine our two main responsibilities of research and teaching. Also, our small size means faculty members all get to interact. I've written papers with Bates colleagues in four different departments, and I have worked with others on shared teaching experiences. There is tremendous opportunity to address cross-disciplinary questions where the disciplines involved are not the "usual" combinations.

What are the most significant challenges you've faced as an interdisciplinary scientist?
Finding collaborators and getting papers accepted. I'm in a lucky place now, with multiple research collaborations, but it was hard at first: you need an interesting project and folks who can work on it with you, and who aren't already completely busy with other things. The moral of that story is: keep trying! Papers are also tricky: as much as I've enjoyed trying my hand at different projects, I admit it is difficult to figure out journal expectations when the journals are in fields that are somewhat new to me. Collaborators can be helpful on this, but projects often fall between our disciplines in such a way that none of us know, initially, where to submit. It takes a lot of time and discussion (and some rejections) to figure this out.

Have you ever found the complexity of biological systems daunting?
Yes, pretty much all the time. However, I have had a crucial experience over and over again: asking a seemingly "stupid" question that ends up shedding important light on our research project. The more I ask these questions—and the more they lead to fruitful discussions—the more likely I am to ask more questions! Furthermore, my collaborators ask their own questions, and we all end up learning in new ways. Both math and biological systems are daunting, and we work through it together.

What are the challenges facing women in academia and how could they be overcome?
These topics are relevant to me both for my own choices and for mentoring others, as I am the senior woman in my department. I have read about challenges facing women in math since long before I came to Bates. There is less explicit bias than in the past, but there remains implicit bias in academic life, as can be seen in nationwide studies. I've been thinking lately about how this affects associate professors: post-tenure, many campuses offer little guidance for their faculty as to what kinds of work are valued toward promotion to full professor. The "protect their time" guideline used for pre-tenure faculty falls away. The AAUP talked about this in an article called The Ivory Ceiling of Service Work (`http://www.aaup.org/article/ivory-ceiling-service-work#.VIelEtKjNo7`). The idea is that, for a complex network of reasons, women get pulled into more service work, and more time spent on teaching, than men at comparable points in their careers. Data sets show that both men and women work roughly the same numbers of hours per week, but women end up with fewer hours for research. Importantly, polls of men and women show that both groups want to spend the same amount of time on research. It's not personal preferences for research, but other factors pulling women away. Meanwhile, fewer women get promoted to full professor on time (or at all). These are incredibly difficult issues to address, as there is no single obvious villain, but instead a whole web of causes. So I can't say I know how they would be overcome, but being aware of their existence and scale is one starting point. And the interwoven nature of the multiple factors involved suggests an extensive mathematical modeling project, don't you think?

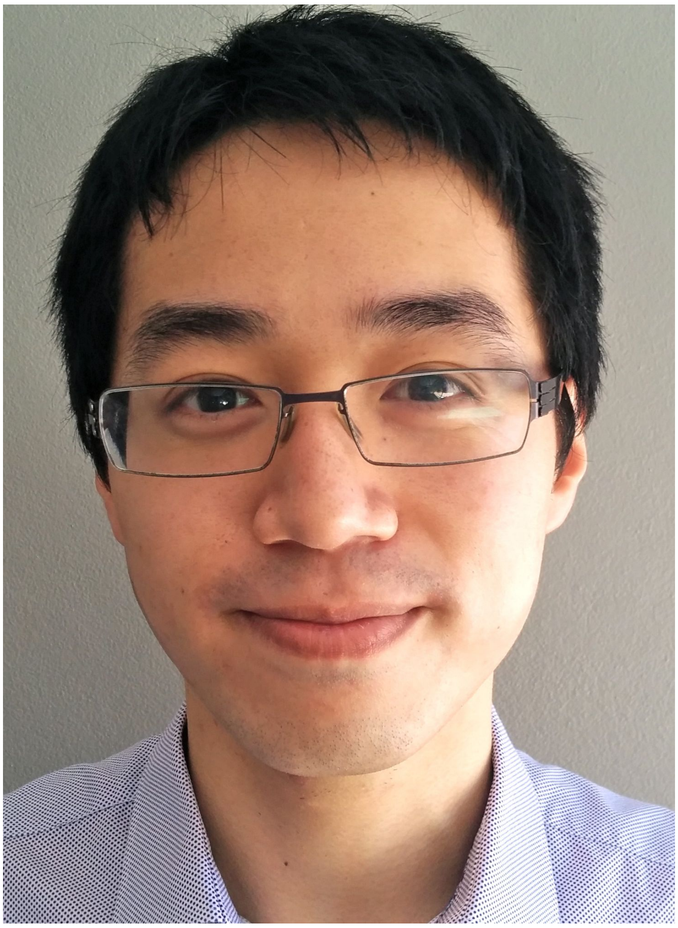
What advice would you give to a young and aspiring mathematical biologist?
For a mathematical biologist starting out at a liberal arts college, I would emphasize the value of professional community. It can be isolating to be at a small college, perhaps as the only mathematical biologist, so seek out local, national, even international communities. SMB, for example, offers opportunities to volunteer, and has an active education committee that is helpful to those of us whose jobs emphasize undergraduate education.

If you have any spare time, what do you do when you are not working?
Most of my non-work time these days is with my husband and our two daughters, ages 2 and 6. I also enjoy my herbs-and-vegetables garden and outdoor activities in Maine. Snowshoeing season has recently arrived, and that is always a favorite!

About Meredith L. Greer
Dr. Meredith Greer is Associate Professor of Mathematics at Bates College. For more info, please visit: `http://abacus.bates.edu/~mgreer/`

The Future of Mathematical Biology

Matthew Chan
The University of Sydney
PhD Student of Dr. Peter Kim



What attracted you to mathematical biology?
I actually didn't know anything about mathematical biology until late in my undergraduate studies when I was introduced to it through two courses by Dr. Martin Wechselberger and Dr. Mary Myerscough. I remember being very impressed by the insight that a simple mathematical model could provide into a biological problem and the occasional mathematical elegance that can arise from it. The idea of distilling a complex biological problem into its core components and then translating this into a mathematical model for analysis was, and still is, very appealing to me.

What is your current research project?
Broadly speaking, I am working on the modeling of spatially-structured populations, with a focus on the evolution of traits (behavioral, life-history etc...) affecting spatial movement. The interplay between the evolutionary and spatial dynamics result in interesting behavior such as accelerating waves and spatial self-structuring in populations, both commonly observed in invasive species. Moreover, I am also interested in the effect on wavespeed and population structure when the population is affected by Allee effects.

What specific areas are you interested investigating?
For the near future, I hope to continue with the theme of modeling population structure and the evolution of traits. In particular, I'm aiming to branch into modeling kin selection in relation to the grand-mothering hypothesis, an area which my PhD supervisor Dr. Peter Kim is also working on. I have also been interested in disease modeling, but have only done things which are on a tangent to this. The problem of properly synthesizing the treasure trove of data out there (in the form of Twitter, Wikipedia access logs, Google Flu Trends etc...) for disease forecasting and using this to fine-tune existing models, is fascinating. Hopefully in the future there will be a chance for me to try my hand at this area.

What do you hope to do after graduation?
I am still undecided on this. Both academia and industry are appealing in their own way. It would be great if I could find something that lies in between!

What advice will you give to an undergraduate interested in a mathematical biology career?
Mathematical Biology is a very interdisciplinary field, and as such, requires knowledge of different fields. I think it is better to not focus too much on "classical" mathematical biology, because if you do graduate studies in mathematical biology, you will definitely end up learning it well enough through research and teaching. Instead, I think it is better to learn things from other related fields such as computer science, biology, statistics and pure mathematics to diversify and expand one's toolset.

What inspires you scientifically?
From a scientific point of view, I find the theory of natural selection very inspiring. It's such a simple

concept from a superficial perspective, but is actually quite complex when examined more closely. Another thing which is inspiring within mathematical biology is seeing researchers from a number of different fields working together and being passionate about the same problem.

Why did you join the Society for Mathematical Biology?
I joined the society because it's important to be actively engaged in the community of one's area of research. It has given me the unique opportunity to network with other students who are in the same field. I particularly found the JSMB/SMB Annual Meeting in 2014 very fruitful and look forward to participating future SMB meetings.

Dr. Peter Kim, Matthew's PhD advisor, says:

I was fortunate to meet Matthew within a year of starting at the University of Sydney. Supervising his PhD program over the past two and a half years has been greatly rewarding and enjoyable. Matthew is highly insightful, creative, and picks up new concepts very quickly, which has enabled him to develop rapidly as a mathematical biologist and researcher. He has an aptitude for extracting unique mathematical questions out of real-world problems and then interpreting results from mathematical research back into their original biological contexts. These skills have enabled him to independently seek out and develop a new collaboration with field biologists who are studying cane toad migration and its impact on the Australian ecosystem.

Not only is his work in mathematical biology flourishing, but he has developed a flair for organizing and communicating research effectively, which led to a prize for the best student talk at the annual Australia and New Zealand conference in applied mathematics this past year. In addition, because of his teaching ability, he was awarded a competitive Postgraduate Teaching Fellowship to provide additional support for his PhD program.

Matthew is definitely a student who will go on to contribute significantly as an academic or industrial researcher, teacher or mentor, and collaborator or co-worker, depending on what career path he chooses. I believe he has strong potential for whatever road he takes. At this point, we will just have to wait and see.

The Future of Math Biology is a column intended to highlight graduate students and postdocs in Mathematical Biology. Do you want to nominate a student or a postdoc from your research group? Please send your nomination to:
Russ Rockne (russrockne(at)gmail(dot)com). Please note that both the nominator and the nominee must be SMB members to qualify for this column.

Editor's Notes

We invite submissions from SMB members including summaries of previous mathematical biology meetings, invitations to upcoming conferences, commentaries, book reviews, or suggestions for other future columns. The deadline is the 15th of the month prior to publication.

The SMB Newsletter is published in January, May, and September by the Society for Mathematical Biology for its members. The Society for Mathematical Biology is an international society that promotes and foster interactions between the mathematical and biological sciences communities through membership, journal publications, travel support and conferences. Please visit our website: http://www.smb.org for more information.

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